The main goals of the project realization are registration and analysis of the seismic-origin motions as well as rotational components existing in engineering structures. The obtained data registered in the seismological observatories contributes to the development of the knowledge about rotational phenomena which appeared after Earthquakes and still appear. It is significant because of the lack of the experimental results in this field due to small amplitude of these events. Moreover, it should be underlined that the classical approach in the seismological monographs excludes the possibility of propagation such movements. There are distinguished only linear motions which can vary in such properties like polarization, velocity or direction of the oscillation. Scientific literature has emphasized that registration even small rotational motions with low potential for causing damage would be useful, especially because of possible cross couplings between rotational and tilt motions. A scientific community has revealed several theoretical investigations of the seismic rotational waves but yet there are limited instances of their experimental confirmation.

Nevertheless, the applicant want to apply highly accurate and sensitive systems to detect the rotational motions - Autonomous Fiber Optic Rotational Seismograph (AFORS) - which have been constructed by the team under the leadership of Professor Jaroszewicz in the Military University of Technology (MUT). The proposed devices base on the Sagnac effect which is a result of a difference between two beams propagating around a closed optical path in the opposite direction. This effect does not require any reference frame. It detects a phase shift with a reference to “the constant stars in the galaxy” instead of to the rotational surface of the Earth. AFORS’s construction comprises two interdependent parts: optical and electric system. The optical part generates a phase shift proportional to measured rotation rate. The electronic system enables to calculate and record information about rotation motions. In order to control AFORS’s operation full remotely via internet we used connection between AFORS and GSM/GPS. Therefore AFORS is completely autonomous and mobile system. The laboratory investigation of the system indicated that it keeps the theoretical sensitivity equal to 10^{-9} rad/s/Hz$^{1/2}$ and accuracy no less than 5.1×10^{-9} to 5.5×10^{-8} rad/s in the chosen detection frequency bandpass from 0.83~106.15 Hz and protects linear changes of the sensitivity in the above bandpass. Such approach enables to detect rotational events in expected frequency range which is suggested as about 0.5–100 Hz by seismological investigation. As a reference system during the realization of this project we will use Twin Antiparallel Pendulum Seismometers (TAPS) constructed by Institute of Geophysics Polish Academy of Sciences. Generally, TAPS consists of two seismometers mounted on common axis and situated in parallel with opposite orientation. The rotational component can be found from linear motions by additional mathematical procedures. The application of two system allows to obtain the data about rotational motions as well as linear motion (from TAPS). Such results give opportunity to carry out the comparative analysis between those two types of motions.

In the second part of the project the applicant will apply the two Fibre−Optic Systems for Rotational Events & Phenomena Monitoring (FOSREM) to register the rotational component of the engineering construction. It will allow to analyze the torsion effects and to determine the inter-storey drift. The torsion effect are caused by asymmetries in the constructions where the center of stiffness differs from the center of mass. The mentioned torsion effects in the buildings were often underestimated because one though that their influence is small and due to lack of the proper recording instruments. It should be underlined that the analysis of these effects is necessary due to the dynamically developing civil engineering which allows to construct the high and complex buildings with an irregular vertical projection. These phenomena in the buildings are characterized by both a high dynamics of a rotation – of the order of 10 rad/s – and lack of a stable reference point. FOSREM ensures wide range of detected signal amplitude and its construction uses innovative technologies in the both optical and electronic parts which allows to apply it to register rotational components in multi-storey engineering structures.

The opportunity to continuously monitor rotational seismic events is very meaningful for the seismological sciences as well as the physics of the large civil engineering objects. In this project we will carry out observations, registrations and deep analysis of the rotational phenomena associated with earthquake and existing in engineering structures.